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Cleaning Quality of Raw Cotton as Affected by Physical Properties of Fibers

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Preface

The amount of cotton which is mechanically harvested is increasing each year as efforts are being made to lower the costs of production through mechanization. Mechanically harvested cotton contains more trash than hand-picked cotton. Trash determines to a considerable degree the grade and price of cotton. The trash content must, therefore, approach that of hand-picked cotton, or the lower grade and price may offset much of the saving made through mechanical harvesting. Hence, the cleaning quality of raw cotton is becoming of greater importance.

Varieties of cotton differ in cleaning quality, some giving up much higher percentages of trash than other varieties. Information as to the causes of these differences may be of value to all those concerned with cotton production and manufacture.

This is a report of a study of the effect of fiber properties on the cleaning quality of 84 cottons. Varieties grown at College Station and Lubbock during 3 seasons and harvested by a mechanical stripper were used. Length, fineness, strength and maturity of the fibers, classer's grade and staple, and the waste were determined.

It was found that the fiber property which had the most effect on cleaning was thickness of the cell wall, frequently called maturity. Although long, fine cotton is more difficult to clean than short, coarse cotton, this difference was found to be due to the greater percentage of thin-walled fibers which generally occurs in long, fine cotton rather than to the greater length and fineness of the fibers. Fibers with thin walls are finer by weight per unit length than those with thick walls.

There are more thin-walled fibers when grown during seasons of heavy rainfall or irrigation than during normal seasons. Wet seasons result in greater plant growth, more trash is harvested with the cotton, and more thin-walled fibers are formed, all of which contribute to the difficulty of cleaning the cotton.

The inter-seed fiber drag (resistance fibers offer to seed separation), apparently does not affect the cleaning quality.

The cleaning quality was not affected by the strength of the fibers.

There was an increase in waste with an increase in height of the plants at Lubbock but not at College Station, perhaps because there was less variation in the plant heights at College Station.

It seems possible that the kind of trash may have more effect on the cleaning quality of cotton than do the fiber properties, a possibility which needs further study.

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Cleaning Quality of Raw Cotton as Affected by the Physical Properties of the Fibers

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Efforts to lower the cost of producing cotton are resulting in greatly accelerated efforts to mechanize all phases of cotton production. Mechanical harvesting increases the amount of trash harvested with the cotton over that harvested by hand picking. Trash is of prime importance in determining the grade of cotton since it is one of the three factors which chiefly determine grade, therefore, affecting the price of cotton. The trash content of mechanically harvested cotton must approach that of hand-picked cotton to minimize a reduction in grade and price of cotton lint. Thus, the problem of cleaning increases in importance as mechanical harvesting increases.

Cottons vary widely in the extent to which they give up trash. It has been found that cottons grown, harvested, cleaned and ginned under identical conditions, differ as much as three grades between types (1). Such a spread between grades has resulted in a difference of $30 or more per bale.

It was thought probable that these differences in cleaning quality might be affected in different degrees by the various physical properties of the fiber. Knowledge of the relative importance of fiber properties in cleaning cotton should be of value to all those who are concerned with cotton breeding, production, harvesting, ginning and manufacturing.

This study was undertaken with the hope of answering some of the questions raised as to the part each of several physical properties plays in cleaning cotton.

Source of Material

The 84 cottons used in this study were grown at the College Station and Lubbock stations during the 1941, 1942 and 1943 seasons. Each season the cottons at any one station were harvested on the

same day or succeeding days. All harvesting, unless otherwise stated, was done with the Texas Station stripper, equipped with an extractor which removed a portion of the trash. Ginning was on a 10-saw gin. The cottons were classed as to grade and staple either by J. M. Ward of the Department of Agricultural Economics and Sociology, or by a board of cotton examiners.

The data on waste in the seedcotton, plant height and fiber drag were furnished by H. P. Smith of the Department of Agricultural Engineering. All cotton samples were furnished by Mr. Smith and by D. T. Killough of the Department of Agronomy. The cottons from Lubbock were grown by D. L. Jones, superintendent of Substation No. 8.

Methods of Analyses

The fiber properties which were determined, include the mean length, the upper quartile length, fineness, strength, immaturity or thickness of cell wall, and the percentage waste. Lengths were measured from arrays made with a Suter-Webb sorter (2). An average of the results of 3 arrays was used for each cotton. Fineness, which is expressed as weight per inch of fiber, was calculated either from the weights of length groups in the arrays, or by the use of a device described elsewhere (3), the results from which were converted into weight in micrograms per inch. Strength was measured with a Pressley breaker and is expressed as an index (4). Immaturity was determined with a polarizing microscope, or by the sodium hydroxide method, or by both methods as a part of another study (5).

The waste was removed in 2 stages: part of it from the seedcotton before and during ginning, and the remainder removed from the ginned cotton or lint with a Shirley analyzer (6). These wastes are expressed either as weight or as percentage of the weight of the cotton before cleaning.

Comparisons between Stations, Seasons and Varieties

Stations

The results of the fiber analyses and the classer's grade and staple for the cottons grown at College Station are given in Table 1, and for the samples of cottons grown at Lubbock in Table 2.

The averages for the 39 cottons grown at College Station and the 45 grown at Lubbock show that those grown at College Station were approximately 1 grade lower. There was no significant difference in average length or fineness, but Lubbock cottons were slight-

ly weaker and slightly more mature. They contained somewhat less waste and released a slightly higher percentage of waste from the seedcotton than cottons grown at College Station.

The range and frequency for each fiber property and the differences between stations may be seen more easily as summarized in Tables 3 and 4.

It is seen that the 84 cottons fall within the 24/32 to 37/32 (¾ to 1 5/32)-inch range in staple, but that most of them, 79 percent, are within the 28/32 to 31/32-inch range with little difference between stations.

The range in fineness is from very fine (below 3 micrograms per inch) to coarse (above 6), with all but 2 falling between 3.6 and 5.9 micrograms per inch. The average fineness for the College Station cottons is 4.8, and for Lubbock 4.6 micrograms per inch, clearly no great difference between stations (Tables 1 and 2).

There are included cottons which are slightly weak (below 8.3 strength index) through those which are of superior strength (above 9.8). Immaturities from very mature (below 22 percent immature) to very immature (over 41 percent) are represented. Only 15 cottons have less than 26 percent or more than 45 percent immature fibers (Table 3).

Only 38 percent of the College Station but 78 percent of the Lubbock cottons contained a total waste of less than 12 grams in 100 grams. The cottons from College Station were more evenly distributed throughout the range of waste removed from the seedcotton than were the Lubbock cottons. Of the 45 Lubbock cottons, 27, or 60 percent, fall within 2 group intervals (36-47.9 percent), as shown in Table 4. Of the College Station cottons, 18, or 46 percent, are within the range of 36-47.9 percent. One Lubbock cotton, and 8 College Station cottons fall within the range of 6 to 29.9 percent.

Seven of the Lubbock cottons, but only 1 of the College Station cottons, had less than 4 percent of waste in 100 grams of lint. The greatest frequency of Lubbock cottons, 19, fall between 4 to 5.9 percent, but the greatest frequency of College Station cottons, 18, fall between 6 to 7.9 percent. The average total waste for the 39 College Station cottons was 13.6 grams and for the 45 Lubbock cottons the average was 10.6 grams (Tables 1 and 2).

Comparisons between the frequencies for the 2 stations show that the 39 cottons grown at College Station are lower in grade, of approximately equal length, are slightly coarser, stronger, more immature and contain more waste than the 45 grown at Lubbock.

Table 1. Physical properties of fibers, trash removed and plant height of varieties of cotton grown at College Station during 3 seasons

No.	Variety	Numerical grade *	Staple 32nd inch	Mean length		Length at 25% point inch	Fineness micrograms per inch	Strength index**	Immaturity %	Trash removed from 100 grams					Fiber drag grams	Av. plant height inches
				Inches	Coef. of variability %					From seed cotton grams	From lint grams	Total grams	From seed-cotton %	From lint %		
							1941									
1	Rogers Texacala	7.0	32	.88	34	1.13	4.1	9.7	35	4.5	7.9	12.4	36	64	.....	29.2
2	Duc. x Lone Star	7.0	30	.78	29	.95	5.2	9.1	37	4.8	6.6	11.4	42	58	.....	27.0
3	H. & H. x Acala	7.0	30	.72	29	.91	5.4	9.2	36	5.3	5.9	11.2	47	53	.....	25.5
4	Okla. Triumph	7.0	29	.72	33	.92	5.6	8.4	39	6.3	8.2	14.5	43	57	.....	29.2
5	Meb. 804 x Meb. 140	7.0	29	.72	27	.88	5.3	9.7	31	5.4	8.0	13.4	40	60	.....	28.9
6	Hi-Bred	7.0	26	.62	31	.80	5.6	8.6	38	10.1	8.4	18.5	55	45	.....	29.2
7	Deltapine 44-51	8.0	32	.86	28	1.04	4.7	9.4	35	5.3	9.0	14.3	37	63	.....	25.5
8	Western Early	8.0	30	.76	32	.97	4.4	8.9	39	6.0	8.7	14.7	41	59	168	25.2
9	Gorhams Lone Star	8.0	30	.87	26	1.06	5.1	8.3	32	8.1	11.2	19.3	42	58	190	21.2
10	Regular Ducona	8.0	29	.82	29	1.00	4.4	9.3	36	5.7	9.4	15.1	38	62	163	31.1
11	Mebane 804-50	8.0	29	.74	29	.92	5.6	8.4	28	6.2	7.7	13.9	45	55	.....	28.9
12	Macha	8.0	28	.72	29	.88	5.4	8.7	36	6.6	11.0	17.6	38	62	.....	25.2
	Average	7.50	29.5	.768	29.7	.955	5.07	8.98	35.2	6.19	8.50	14.69	42.0	58.0	173.7	27.18
							1942									
13	Rogers Texacala	5.5	31	.67	40	.92	4.1	9.9	45	3.1	7.5	10.6	29	71	175	28.0
14	Hi-Bred	5.5	26	.54	34	.72	6.3	8.9	40	9.6	4.7	14.3	67	33	253	27.4
15	Greer 5-3	6.0	31	.77	33	.99	4.4	9.8	48	1.4	7.0	8.4	17	83	200	24.9
16	Deltapine 14	6.0	30	.76	34	.99	4.4	9.5	36	5.5	7.0	12.5	44	56	.....	24.5
17	Gorhams Lone Star	6.0	30	.72	33	.93	5.4	8.9	32	2.4	6.0	8.4	29	71	.....	26.3
18	Mebane 804-50	6.0	29	.71	30	.88	5.6	8.1	27	4.5	6.0	10.5	43	57	175	30.1
19	Holtz	6.0	29	.75	34	.98	5.3	9.8	38	2.5	6.3	8.8	28	72	200	26.3
20	Suntex	6.0	28	.71	37	.94	5.2	9.2	33	2.2	7.7	9.9	22	78	100	29.0
21	Okla. Triumph	6.5	30	.62	37	.85	5.0	8.7	42	4.9	7.6	12.5	39	61	150	24.0
22	Stoneville 2 B	7.0	31	.76	34	.99	4.5	9.5	43	8.1	6.9	15.0	54	46	175	27.0
23	Western Early	7.0	30	.73	32	.94	4.4	9.6	36	9.3	6.9	16.2	57	43	135	26.1
24	Roldo Rowden	7.0	30	.70	34	.92	5.6	8.8	28	3.1	6.9	10.0	31	69	175	26.1
25	Macha	7.0	29	.62	34	.82	5.3	8.8	41	3.8	12.5	16.3	23	77	175	24.3
26	Regular Ducona	7.0	28	.73	33	.95	4.6	10.0	36	3.1	8.2	11.3	27	73	.....	30.9
27	Western Meb. 140	7.0	24	.62	31	.80	5.6	8.8	29	3.7	10.6	14.3	26	74	154	26.1
	Average	6.37	29.1	.694	34.0	.908	5.05	9.22	36.9	4.48	7.45	11.93	35.7	64.3	172.2	26.73

28	Rogers Texacala.....	5.0	29	.66	41	.92	3.7	9.5	41	4.8	5.1	9.9	48	52	175	26.3
29	Holtz.....	5.5	28	.61	39	.84	5.0	9.3	29	6.5	6.8	13.3	49	51	76	25.4
30	Okla. Triumph.....	6.0	30	.63	36	.87	4.1	9.2	42	6.0	5.8	11.8	51	49	67	28.0
31	Roldo Rowden.....	6.0	29	.65	35	.86	5.4	9.1	29	5.7	5.2	10.9	52	48	137	26.3
32	Suntex.....	6.0	29	.68	31	.85	4.9	9.0	31	7.3	3.9	11.2	65	35	100	26.1
33	Western Early.....	6.0	28	.60	41	.84	3.7	9.1	44	5.9	10.4	16.3	36	64	99	26.3
34	Regular Ducona.....	6.0	28	.69	35	.92	3.8	9.9	49	5.0	7.5	12.5	40	60	66	26.5
35	Western Meb. 140....	6.0	28	.59	31	.79	4.9	8.9	32	6.7	4.9	11.6	58	42	147	28.1
36	Arkansas B 5.....	6.0	26	.56	43	.82	4.6	8.9	38	6.4	7.4	13.8	46	54	94	25.8
37	Gorhams Lone Star...	6.5	28	.61	42	.89	3.7	9.5	41	7.5	7.5	15.0	50	50	60	19.8
38	Deltapine 14.....	7.0	28	.69	38	.85	3.9	9.0	40	5.7	11.8	17.5	33	67	97	26.1
39	Coker's Wilds 15.....	7.5	35	.83	39	1.10	2.9	9.9	50	14.2	15.5	29.7	48	52	.....	28.4
	Average.....	6.12	28.8	.650	37.6	.879	4.22	9.28	38.8	6.81	7.65	14.56	48.0	52.0	111.9	26.09
	Average for 3 seasons..	6.64	29.1	.703	33.8	.914	4.80	9.16	37.0	5.72	7.84	13.56	41.4	58.6	148.1	26.67

*The cotton grades are designated as follows:

2. Strict Good Middling (SGM)
3. Good Middling (GM)
4. Strict Middling (SM)
5. Middling (M)
6. Strict Low Middling (SLM)
7. Low Middling (LM)
8. Strict Good Ordinary (SGO)
9. Good Ordinary (GO)

**Pressley index may be converted to strength in 1,000 lbs. per square inch by the formula:
Tensile strength = (10.8116 X Pressley index) —0.12

Table 2. Physical properties of fibers, trash removed and plant height of varieties of cotton grown at Lubbock during 3 seasons

No.	Variety	Numerical grade *	Staple 32nd inch	Mean length		Length at 25% point inch	Fineness micrograms per inch	Strength index**	Immaturity %	Trash removed from 100 grams					Fiber drag grams	Av. plant height inches
				Inches	Coef. of variability %					From seed cotton grams	From lint grams	Total grams	From seed-cotton %	From lint %		
							1941									
40	Lock. Mebane 140	4.5	29	.73	26	.88	5.6	9.2	35	3.7	3.7	7.4	50	50	.....	24.0
40	Hi-Bred	5.0	29	.75	27	.91	5.4	8.2	31	3.6	5.9	9.5	38	62	.....	20.8
42	H. & H. x Acala	5.0	28	.72	32	.92	5.5	8.3	34	0.5	6.9	7.4	7	93	.....	24.1
43	Ducona x Lone Star	5.5	30	.85	30	1.03	5.0	8.0	34	4.2	5.7	9.9	42	58	.....	20.0
44	Deltapine	6.0	31	.82	38	1.05	4.5	8.4	34	4.4	5.2	9.6	46	54	.....	26.7
45	Western Early	6.0	30	.84	30	.90	4.4	8.7	33	5.7	5.7	11.4	50	50	.....	25.5
46	Meb. 804 x Meb. 140	6.0	30	.79	36	.99	4.6	9.0	32	4.7	5.4	10.1	46	54	.....	23.5
47	Clark x Meb. 140	6.0	29	.73	29	.90	4.9	8.6	39	4.0	4.9	8.9	45	55	.....	21.4
48	Ferguson 406	6.0	29	.74	31	.92	5.6	7.1	32	4.2	4.8	9.0	47	53	.....	25.0
49	Macha	6.5	29	.76	28	.91	5.5	8.0	33	6.3	6.1	12.4	51	49	.....	23.5
50	Rogers Acala	7.0	29	.89	35	1.13	4.1	9.1	37	4.6	7.0	11.6	40	60	.....	28.6
	Average	5.77	29.4	.784	31.1	.958	5.01	8.42	34.0	4.17	5.57	9.74	42.0	58.0	.....	23.92
							1942									
51	Okla. Tri. x Cl. x Cl	5.0	31	.80	35	1.03	4.3	8.3	37	6.2	7.0	13.2	47	53	145	23.8
52	Macha (Jones)	5.0	30	.81	37	1.03	3.8	9.0	38	4.6	7.1	11.7	39	61	125	33.3
53	Hi-Bred	5.0	28	.66	40	.94	4.3	8.2	40	3.3	7.5	10.8	31	69	238	34.7
54	Western Early	5.5	31	.75	40	1.02	3.9	8.1	42	6.8	9.4	16.2	42	58	176	37.1
55	Sh. x H. & H. x Shafter	5.5	30	.72	43	1.04	3.7	8.4	60	4.2	7.6	11.8	36	64	160	46.3
56	Macha x Acala	5.5	29	.74	40	1.03	4.0	8.4	42	6.6	14.0	20.6	32	68	139	44.5
57	Lock. Mebane 140	5.5	29	.75	36	.98	4.3	8.2	33	3.1	5.8	8.9	35	65	160	37.9
58	Ferguson 406	5.5	26	.72	36	.98	4.2	7.3	43	4.2	6.0	10.2	41	59	136	38.9
59	Duc. x Cl. x Duc	6.0	33	.81	38	1.09	4.2	8.0	35	4.6	5.8	10.4	44	56	122	34.4
60	Deltapine	6.0	29	.72	41	.98	4.2	8.0	43	6.6	7.4	14.0	47	53	115	37.6
61	Macha (Macha)	6.0	29	.70	38	.94	4.6	7.8	37	6.4	10.3	16.7	38	62	200	37.4
62	St. x H. & H. x St. 117	6.0	29	.68	41	.96	4.0	8.4	44	6.4	9.5	15.9	40	60	205	36.9
63	St. x H. & H. x St. 111	6.0	28	.68	41	.96	4.1	8.5	36	6.2	8.1	14.3	43	57	137	38.1
64	H. & H. x Acala	6.5	24	.65	46	.97	4.0	8.0	43	6.2	9.9	16.1	38	62	176	33.6
	Average	5.64	29.0	.728	39.4	.996	4.11	8.18	40.9	5.38	8.24	13.63	39.5	60.5	159.6	36.75

65	Western Early 4/63	4.0	30	.68	35	.92	5.0	8.8	28	4.8	4.4	9.2	52	48	.....	.....
66	Macha x Acala 6/68-98	4.0	28	.73	34	.95	4.9	9.1	21	3.4	4.8	8.2	42	58	.....	.....
67	Macha x Acala 4/5	4.0	28	.56	43	.79	4.3	9.3	25	3.8	6.3	10.1	38	62	.....	.....
68	Okl. Tri x Cl x Cl 3/67	4.5	28	.62	32	.81	5.4	8.7	19	3.6	6.5	10.1	36	64	.....	.....
69	Hi-Bred	4.5	26	.62	29	.78	5.2	8.9	22	3.6	2.6	6.2	58	42	228	17.2
70	Rogers Acala	5.0	33	.76	38	1.02	4.4	10.0	24	3.1	4.4	7.5	41	59	.....	.....
71	H. & H. x Acala 1/7	5.0	32	.72	35	.95	4.7	9.4	30	3.2	4.0	7.2	44	56	.....	.....
72	Macha 5/40	5.0	29	.68	36	.91	4.2	8.8	29	6.7	5.6	12.3	54	46	.....	.....
73	West. Early x Macha 2/14	5.0	28	.72	33	.95	5.1	9.1	21	5.6	4.4	8.0	45	55	.....	.....
74	Clark x Missdell 3/50	5.0	28	.68	36	.93	4.6	8.8	24	4.2	5.5	9.7	43	57	.....	.....
75	Macha x Acala 4/7	5.0	28	.65	38	.90	4.4	9.2	29	3.8	3.9	7.7	49	51	.....	.....
76	Western Early 4/61	5.0	28	.68	31	.89	4.8	7.9	29	3.7	4.3	8.0	46	54	.....	.....
77	Western Early 4/60	5.0	28	.69	28	.87	5.2	8.4	22	4.6	6.6	11.2	41	59	.....	.....
78	Duc x Cl x Duc x Duc 5/63	5.0	26	.70	30	.88	5.2	8.5	21	4.5	2.2	6.7	67	33	.....	.....
79	Western Early 5/65	5.0	26	.67	29	.84	5.2	8.4	19	3.5	3.3	6.8	52	48	.....	.....
80	West. Early x Macha 4/40	5.0	26	.61	37	.83	5.0	9.3	20	3.0	4.7	7.7	39	61	.....	.....
81	Coker's Wilds 15	5.5	36	.82	32	1.09	3.4	9.8	35	6.0	5.3	11.3	53	47	109	21.2
82	St. x H. & H. x St. 1/28	5.5	28	.69	35	.90	5.4	9.0	18	4.8	3.4	8.2	58	42	.....	.....
83	Macha 5/25	5.5	26	.66	32	.85	4.9	8.7	28	5.0	6.8	11.8	42	58	.....	.....
84	Deltapine 14	6.0	30	.72	31	.95	4.2	8.8	32	7.0	3.7	10.7	65	35	128	20.3
	Average	4.92	28.6	.683	33.7	.900	4.78	8.94	24.8	4.30	4.64	8.93	48.2	50.8	155.0	19.57
	Average for 3 seasons	5.36	28.9	.722	34.8	.944	4.63	8.58	32.1	4.60	5.99	10.59	44.0	55.6	158.8	29.87
	Av. for both stations	5.95	28.6	.713	34.3	.930	4.70	8.85	34.3	5.12	6.84	11.97	42.8	57.0	157.3	28.01

*The cotton grades are designated as follows:

2. Strict Good Middling (SGM)
3. Good Middling (GM)
4. Strict Middling (SM)
5. Middling (M)
6. Strict Low Middling (SLM)
7. Low Middling (LM)
8. Strict Good Ordinary (SGO)
9. Good Ordinary (GO)

**Pressley index may be converted to strength in 1,000 lbs. per square inch by the formula:
Tensile strength = (10.8116 x Pressley index)—0.12

Table 3. Range and frequency of the length, fineness, strength and immaturity of fibers from cotton varieties grown at College Station and Lubbock

Staple	Frequency		
32nd inch	College Stations	Lubbock	Both stations
24.0–25.0	1	1	2
26.0–27.0	3	6	9
28.0–29.0	19	24	43
30.0–31.0	13	10	23
32.0–33.0	2	3	5
34.0–35.0	1	.....	1
36.0–37.0	.....	1	1
Total No.	39	45	84

Mean length	Frequency		
Inch	College Station	Lubbock	Both stations
.54–.59	3	1	4
.60–.65	9	5	14
.66–.71	8	13	21
.72–.77	13	17	30
.78–.83	3	6	9
.84–.89	3	3	6
.90–.95	.....	.....	.....
Total No.	39	45	84

Upper quartile length	Frequency		
Inch	College Station	Lubbock	Both stations
.72– .79	2	2	4
.80– .87	11	5	16
.88– .95	16	20	36
.96–1.03	6	13	19
1.04–1.11	3	4	7
1.12–1.19	1	1	2
Total No.	39	45	84

Fineness	Frequency		
Microgram per inch	College Station	Lubbock	Both stations
2.8–3.5	1	1	2
3.6–4.3	8	17	25
4.4–5.1	14	16	30
5.2–5.9	15	11	26
6.0–6.7	1	.....	1
Total No.	39	45	84

Strength index	Frequency		
Pressley index	College Station	Lubbock	Both stations
7.1– 7.4	.....	2	2
7.5– 7.8	.....	1	1
7.9– 8.2	1	10	11
8.3– 8.6	4	11	15
8.7– 9.0	12	11	23
9.1– 9.4	9	8	17
9.5– 9.8	8	1	9
9.9–10.2	5	1	6
Total No.	39	45	84

Immaturity	Frequency		
Percent	College Station	Lubbock	Both stations
18.0–21.0	.....	7	7
22.0–25.0	.....	5	5
26.0–29.0	6	5	11
30.0–33.0	6	8	14
34.0–37.0	9	11	20
38.0–41.0	10	3	13
42.0–45.0	5	6	11
46.0–49.0	2	.....	2
50.0–53.0	.....	.....	1
Total No.	39	45	84

Table 4. Range and frequency of grade and waste of cotton grown at College Station and Lubbock

Grade

Numerical grade		Frequency		
		College Station	Lubbock	Both stations
SM	3 5–4.4	.....	3	3
M	4.5–5.4	1	19	20
SLM	5.5–6.4	16	20	36
LM	6.5–7.4	15	3	18
SGO	7.5–8.4	7	.....	7
Total No.		39	45	84

Total waste

Percent	Frequency		
	College Station	Lubbock	Both stations
6.0– 7.9	.....	9	9
8.0– 9.9	5	12	17
10.0–11.9	10	14	24
12.0–13.9	8	3	11
14.0–15.9	8	3	11
16.0–17.9	5	3	8
18.0–19.9	2	.....	2
20.0–21.9	.....	1	1
.....	.....		
28.0–29.9	1	.....	1
Total No.	39	45	84

Waste removed from seed cotton

Percent	Frequency		
	College Station	Lubbock	Both stations
6.0–11.9	.....	1	1
12.0–17.9	1	.....	1
18.0–23.9	2	.....	2
24.0–29.9	5	.....	5
30.0–35.9	2	5	7
36.0–41.9	9	12	21
42.0–47.9	9	15	24
48.0–53.9	5	7	12
54.0–59.9	4	3	7
60.0–65.9	1	1	2
66.0–71.9	1	1	2
Total No.	39	45	84

Waste in 100 grams lint

Percent	Frequency		
	College Station	Lubbock	Both stations
2.0– 3.9	1	7	8
4.0– 5.9	6	19	25
6.0– 7.9	18	13	31
8.0– 9.9	7	4	11
10.0–11.9	5	1	6
12.0–13.9	1	.....	1
14.0–15.9	1	1	2
Total No.	39	45	84

Seasons

Since 6 varieties at College Station and 5 at Lubbock were grown each of the 3 seasons, it is possible to compare differences due to the season (Tables 5 and 6).

In 5 of the 6 varieties grown 3 seasons at College Station, there is a difference of 2 grades and in 1 (Oklahoma Triumph) a difference of 1 grade due to season (Table 5). In all 6 varieties, the grade is higher for 1943 than for 1941. In 4 of these 6 varieties there is more waste in 1941 than in either 1942 or 1943.

All varieties grown at both stations for 3 seasons, with 1 exception, were finer in 1943 than in 1941, with less difference between 1941 and 1942.

Of the 6 varieties grown 3 seasons at College Station, those grown in 1941 were most mature followed by those grown in 1942 and 1943 respectively (Table 5). Of the 5 varieties grown 3 seasons at Lubbock, those varieties grown in 1943 were most mature followed by those grown in 1941 and 1942 respectively (Table 6).

Table 5. Physical properties of fibers, trash removed and plant height of 12 varieties of cotton grown each of 2 or 3 seasons at College Station

Variety	Season	Numerical grade	Staple 32nd inch	Upper quartile length inches	Mean length		Fineness micrograms per inch	Strength index	Immaturity %	Waste from 100 grams				Average plant height inches
					Inch	c. of v. %				Total weight removed grams	Removed from seed cotton %	Removed from lint %	Wt. in 100 gms. of lint grams	
Rogers Texacala	1941	7.0	32	1.13	.88	34	4.1	9.7	35	12.4	36	64	7.9	29.2
	1942	5.5	31	.92	.67	40	4.1	9.9	45	10.6	29	71	7.5	28.0
	1943	5.0	29	.92	.67	41	3.7	9.5	41	9.9	48	52	5.1	26.3
	Average	5.8	31	.99	.74	38.3	3.97	9.70	40	11.0	37.7	62.3	6.8	27.8
Okla. Triumph	1941	7.0	29	.92	.72	33	5.6	8.4	39	14.5	43	57	8.2	29.2
	1942	6.5	30	.85	.62	37	5.0	8.7	42	12.5	39	61	7.6	24.0
	1943	6.0	30	.87	.63	36	4.1	9.2	42	11.8	51	49	5.8	28.0
	Average	6.5	30	.88	.66	35.3	4.90	8.77	41	12.9	44.3	55.7	7.2	27.1
Western Early	1941	8.0	30	.97	.76	32	4.4	8.9	39	14.7	41	59	8.7	25.2
	1942	7.0	30	.94	.73	32	4.4	9.6	36	16.2	57	43	6.9	26.1
	1943	6.0	28	.84	.60	41	3.7	9.1	44	16.3	36	64	10.4	26.3
	Average	7.0	29	.92	.70	35.0	4.17	9.20	40	15.7	44.7	55.3	8.7	25.9
Deltapine	1941	8.0	32	1.04	.86	28	4.7	9.4	35	14.3	37	63	9.0	25.5
	1942	6.0	30	.99	.76	34	4.4	9.5	36	12.5	44	56	7.0	24.5
	1943	7.0	28	.85	.62	38	3.9	9.0	40	17.5	33	67	11.8	26.1
	Average	7.0	30	.96	.75	33.3	4.33	9.30	37	14.8	38.0	62.0	9.3	25.4
G. Lone Star	1941	8.0	30	1.06	.87	26	5.1	8.3	32	19.3	42	58	11.2	21.2
	1942	6.0	30	.93	.72	33	5.4	8.9	32	8.4	29	71	6.0	26.3
	1943	6.5	28	.89	.61	42	3.7	9.5	41	15.0	50	50	7.5	19.8
	Average	6.8	29	.96	.73	33.7	4.73	8.90	35	14.2	40.3	59.7	8.2	22.4
Regular Ducona	1941	8.0	29	1.00	.82	29	4.4	9.3	36	15.1	38	62	9.4	31.1
	1942	7.0	28	.95	.73	33	4.6	10.0	36	11.3	27	73	8.2	30.9
	1943	6.0	28	.92	.69	35	3.8	9.9	49	12.5	40	60	7.5	26.5
	Average	7.0	28	.96	.75	32.3	4.27	9.73	40	13.0	35.0	65.0	8.4	29.5
Average for 1941		7.7	30	1.02	.82	30.3	4.72	9.00	36	15.0	39.5	60.5	9.1	26.9
Average for 1942		6.3	30	.93	.70	34.8	4.65	9.43	38	11.9	37.5	62.5	7.2	26.6
Average for 1943		6.1	28	.88	.64	38.8	3.82	9.37	43	13.8	43.0	57.0	8.0	25.5

Hi-Bred	1941	7.0	26	.80	.62	31	5.6	8.6	38	18.5	55	45	8.4	29.2
	1942	5.5	26	.72	.54	34	6.3	8.9	40	14.3	67	33	4.7	27.4
	Average	6.2	26	.76	.58	32.5	5.95	8.75	39	16.4	61.0	39.0	6.6	28.3
Meb. 804-50	1941	8.0	29	.92	.74	29	5.6	8.4	28	13.9	45	55	8.0	28.9
	1942	6.0	29	.88	.71	30	5.6	8.1	27	10.5	43	57	6.0	30.1
	Average	7.0	29	.90	.72	29.5	5.60	8.25	28	12.2	44.0	56.0	7.0	29.5
Macha	1941	8.0	28	.88	.72	29	5.4	8.7	36	17.6	38	62	11.0	25.2
	1942	7.0	29	.82	.62	34	5.3	8.8	41	16.3	23	77	12.5	24.3
	Average	7.5	28	.85	.67	31.5	5.35	8.75	38	17.0	30.5	69.5	11.8	24.8
Average for 1941.....	.....	7.7	28	.87	.69	29.7	5.53	8.57	34	16.7	46.0	54.0	9.1	27.8
Average for 1942.....	.....	6.2	28	.81	.62	32.7	5.73	8.60	36	13.7	44.3	55.7	7.7	27.3
Holtz	1942	6.0	29	.98	.75	34	5.3	9.8	38	8.8	28	72	6.3	26.3
	1943	5.5	28	.84	.61	39	5.0	9.3	29	13.3	49	51	6.8	25.4
	Average	5.8	28	.91	.68	36.7	5.15	9.55	34	11.0	38.5	61.5	6.6	25.9
Suntex	1942	6.0	28	.94	.71	37	5.2	9.2	33	9.9	22	78	7.7	29.0
	1943	6.0	29	.85	.68	31	4.9	9.0	31	11.2	65	35	3.9	26.1
	Average	6.0	28	.90	.70	34.0	5.05	9.10	32	10.6	43.5	56.5	5.8	27.6
Roldo Rowden	1942	7.0	30	.92	.70	34	5.6	8.8	28	10.0	31	69	6.9	26.1
	1943	6.0	29	.86	.65	35	5.4	9.1	29	10.9	52	48	5.2	26.3
	Average	6.5	30	.89	.68	34.5	5.47	8.95	28	10.4	41.5	58.5	6.0	26.2
Average for 1942.....	.....	6.3	29	.95	.72	35.0	5.37	9.27	33	9.6	27.0	73.0	7.0	27.1
Average for 1943.....	.....	5.8	29	.85	.65	35.0	5.10	9.13	30	11.8	55.3	44.7	5.3	25.9

Table 6. Physical properties of fibers, trash removed and plant height of 10 varieties of cotton grown each of 2 or 3 seasons at Lubbock

Variety	Season	Numerical grade	Staple 32nd inch	Upper quartile length inches	Mean length		Fineness micrograms per inch	Strength index	Immaturity %	Waste from 100 grams				Average plant height inches
					Inch	c. of v. %				Total weight removed grams	Removed from seed cotton %	Removed from lint %	Wt. in 100 gms. of lint grams	
H. & H. x Acala	1941	5.0	28	.92	.72	32	5.5	8.3	34	7.4	7	93	6.9	24.1
	1942	6.5	24	.97	.65	46	4.0	8.0	43	16.1	38	62	9.9	33.6
	1943	5.0	32	.95	.76	35	4.7	9.4	30	7.2	44	56	4.0	.....
	Average	5.5	28	.95	.71	37.7	4.73	8.56	36	10.2	29.7	70.3	6.9	28.8
Hi-Bred	1941	5.0	29	.91	.75	27	5.4	8.2	31	9.5	38	62	5.9	20.8
	1942	5.0	28	.94	.66	40	4.3	8.2	40	10.8	31	69	7.5	34.7
	1943	4.5	26	.78	.62	29	5.2	8.9	22	6.2	58	42	2.6	17.2
	Average	4.8	28	.88	.68	32.0	4.97	8.43	31	8.8	42.3	57.7	5.3	24.2
Deltapine	1941	6.0	31	1.05	.82	38	4.5	8.4	34	9.6	46	54	5.2	26.7
	1942	6.0	29	.98	.72	41	4.2	8.0	43	14.0	47	53	7.4	37.6
	1943	6.0	30	.95	.77	31	4.2	8.8	32	10.7	65	35	3.7	20.3
	Average	6.0	30	.99	.77	36.7	4.30	8.40	36	11.4	52.7	47.3	5.4	28.2
Western Early.....	1941	6.0	30	.90	.84	30	4.4	8.7	33	11.4	50	50	5.4	25.5
	1942	5.5	31	1.02	.75	40	3.9	8.1	42	16.2	42	58	9.4	37.1
	1943	4.8	28	.88	.68	31	5.1	8.4	24	8.8	48	52	4.6	.....
	Average	5.4	30	.93	.76	33.7	4.47	8.40	33	12.1	46.7	53.3	6.5	31.3
Macha	1941	6.5	29	.91	.76	28	5.5	8.0	33	12.4	51	49	6.1	23.5
	1942	6.0	29	.94	.70	38	4.6	7.8	37	16.7	38	62	10.3	37.4
	1943	5.2	28	.88	.66	32	4.6	8.8	28	12.0	48	52	6.2	.....
	Average	5.9	29	.91	.71	32.7	4.90	8.20	33	13.7	45.8	54.3	7.5	30.4
Average for 1941.....	.....	5.7	29	.94	.78	31.0	5.06	8.32	33	10.1	38.4	61.6	5.9	24.1
Average for 1942.....	.....	5.8	28	.97	.70	41.0	4.20	8.02	41	14.8	39.2	60.8	8.9	36.1
Average for 1943.....	.....	5.1	29	.89	.70	31.6	4.76	8.86	27	9.0	52.6	47.4	4.2	18.8

Mebane 140	1941	4.5	29	.88	.73	26	5.6	9.2	35	7.4	50	50	3.7	24.0
	1942	5.5	29	.98	.75	36	4.3	8.2	33	8.9	35	65	5.8	37.9
	Average	5.0	29	.93	.74	31.0	4.95	8.70	34	8.2	42.5	57.5	4.8	31.0
Rogers Acala	1941	7.0	29	1.13	.89	35	4.1	9.1	37	11.6	40	60	7.0	28.6
	1943	5.0	33	1.02	.76	38	4.4	10.0	24	7.5	41	59	4.4	.....
	Average	6.0	31	1.08	.82	36.5	4.25	9.55	30	9.6	40.5	59.5	5.7	.....
Okla. Tri. x Cl. x Cl...	1942	5.0	31	1.03	.80	35	4.3	8.3	37	13.2	47	53	7.0	.....
	1943	4.5	28	.81	.62	32	5.4	8.7	19	10.1	36	64	10.1	.....
	Average	4.8	30	.92	.71	33.5	4.85	8.50	28	11.6	41.5	58.5	8.6	.....
Ferguson 406	1941	6.0	29	.92	.74	31	5.6	7.1	32	9.0	47	53	4.8	25.0
	1942	5.5	26	.98	.73	36	4.2	7.3	43	10.2	41	59	6.0	38.9
	Average	5.8	28	.95	.74	33.5	4.90	7.20	38	9.6	44.0	56.0	5.4	32.0
Macha x Acala	1942	5.5	29	1.03	.74	40	4.0	8.4	42	20.6	32	68	14.0	.....
	1943	4.3	28	.88	.65	38	4.5	9.2	25	8.6	43	57	8.7	.....
	Average	4.9	28	.96	.70	39.0	4.25	8.80	34	14.6	37.5	62.5	11.4	.....

For the 6 varieties grown for 2 seasons, either 1941 and 1942, or 1942 and 1943, at College Station, the grade is higher for the later season, with 1 exception where it is the same for both seasons (Table 5). There is no difference in average staple between the 2 seasons, but the mean length is slightly shorter the second season. With 2 exceptions, there are no great differences between the seasons for fineness, strength and maturity. There are, however, significant differences in the percentages of waste removed from the seedcotton. A much higher percentage was removed from Hi-Bred and much lower from Macha in 1942 than in 1941. In all cases there was more waste for the 1941 than the 1942 seasons. For the 3 varieties grown in 1942 and 1943, both the total waste and the percentage removed from the seedcotton were less in 1942 than in 1943, although there are no great differences in fiber properties.

The most striking seasonal differences occurred at Lubbock in Half and Half X Acala (Table 6). In 1942 the cotton was classed 1½ grades lower and 4/32 and 8/32 inches shorter than in 1941 and 1943 respectively. The fibers were much finer and less mature in 1942 and there was more than twice as much waste than for the other 2 seasons. This same variety released approximately 7 percent of its trash in 1941 in contrast with 38 and 44 percent the other seasons. The fiber properties suggest no explanation for the apparent great difference in cleaning quality of this variety for the 3 seasons.

In general, there were improvements in grade with succeeding seasons for both stations. These improvements cannot be assigned to changes in the methods of harvesting or cleaning and must, therefore, be attributed to seasonal or varietal differences.

Varieties

Differences in cottons grown at each station within a given season must be attributed to differences between varieties since all were grown and harvested under the same conditions.

Varieties differed by as much as 2½ grades, 10/32 inch in staple, 2.5 micrograms per inch for fineness, 27 percent in maturity, and 2.1 by Pressley index in strength (Tables 1 and 2). Thus, it is seen that varieties of considerable difference in grade and fiber properties are included among the 84 cottons.

Relationship between Waste and Grade

In comparing grades and waste certain facts must be kept in mind. The classer judges the amount of waste chiefly by the area it occupies in a sample, while it is given herein on the basis of

weight. Thus, waste by the two methods may not always agree. To illustrate, waste composed of leaves occupies a relatively large surface area, but the same weight of sand, which occupies much less area, has less effect on grade than does the leaf trash.

A portion of these cottons was classed by a board of cotton examiners who assigned separate grades to leaf and color, 2 of the 3 properties (leaf, color and preparation) which are included in grade. That there was a close relationship between waste and the grades of the leaf and color is shown by comparison of the average waste for each grade as follows:

Leaf		Color	
Grade	Waste	Grade	Waste
	%		%
4	5.2	4.5	5.0
5	4.3	5	5.6
6	5.6	6	7.2
7	8.5	7	16.5
8	22.0		

Correlation coefficients for the composite grade (including leaf, color and preparation) with waste for the 84 cottons are highly significant. The multiple correlation coefficient of grade as the dependent factor with both waste and the fiber properties is 0.73. The simple correlation between grade and waste is -0.58. The partial correlation coefficient between grade and waste, independent of the fiber properties which were measured, is -0.55. This is little different from the simple coefficient, indicating that of the factors studied, waste accounted for practically all of the differences in grades.

Relationship between Waste and Classer's Staple

There was found to be little relation between the waste or trash in the cotton and the classer's estimate of the staple of the 84 cottons. The correlation coefficient is 0.098, which is not significant.

Forty-seven of these cottons were classed as to staple by a board of cotton examiners (using unpaired samples) before and after the trash was removed with the Shirley analyzer (Table 7). Thus, the differences in the classer's staple may be attributed in part to the effect of cleaning.

Cleaning did not change the staple of 12 of the 47 cottons. Six gained 1/32, and 1 gained 2/32 inch. Twenty lost 1/32 to 2/32 inch and 8 lost from 3/32 to 5/32 inch. The average change was a loss of slightly more than 1/32 inch. However, in 60 cottons reported elsewhere (7) the average change in staple due to cleaning was less, 2/5 of 1/32 inch, which is not significant.

Table 7. Staple length of cotton fibers as given by classers before and after removal of waste by Shirley analyzer

Variety	Staple		Numerical grade before cleaning	Waste removed %	Mean length inch	Fineness micrograms/inch	Strength index	Immaturity %
	Change by cleaning 32nd inch	Before cleaning 32nd inch						
Western Early	0	30	6.0	5.7	.84	4.4	7.1	31
Gorhams Lone Star	0	28	6.5	7.5	.61	3.7	7.9	41
Ducona x Lone Star	0	30	5.5	5.7	.85	5.0	6.4	34
Regular Ducona	0	28	6.0	7.5	.69	3.8	8.3	43
Deltapine 14	0	28	7.0	11.8	.69	3.9	7.4	40
Western Early 4/61	0	28	5.0	4.3	.68	4.8	6.3	23
Macha 5/25	0	26	5.5	6.8	.66	4.9	7.1	26
Western Early	0	28	6.0	10.4	.60	3.7	7.5	44
Clark x Missdale 3/50	0	28	5.0	5.5	.68	4.6	7.2	34
West. Early x Macha 4/40	0	26	5.0	4.7	.61	5.0	7.7	20
Macha x Acala 4/5	0	28	4.0	6.3	.56	4.3	7.7	23
Western Early 5/65	0	26	5.0	3.3	.67	5.2	6.8	19
Meb. 804 x Meb. 140	−1	30	6.0	5.4	.79	4.6	7.4	33
Clark x Meb. 140	−1	29	6.0	4.9	.73	4.9	7.0	30
Regular Ducona	−1	29	8.0	9.4	.82	4.4	7.7	36
Suntex	−1	29	6.0	3.9	.68	4.9	7.4	31
Macha 5/40	−1	29	5.0	5.6	.68	4.2	7.2	29
Rogers Texacala	−1	29	5.0	5.1	.66	3.7	7.9	41
Hi-Bred	−1	29	5.0	5.9	.75	5.4	6.6	31
Lock. Mebane 140	−1	29	4.5	3.7	.73	5.6	7.6	35
Macha	+1	29	6.5	6.1	.76	5.5	6.4	33
Ferguson 406	+1	29	6.0	4.8	.74	5.6	5.5	32
Rogers Acala	+1	29	7.0	7.0	.89	4.1	7.5	37
Oklahoma Triumph	+1	29	7.0	8.2	.72	5.6	6.8	33
West. Early x Macha 2/14	+1	28	5.0	4.4	.72	5.1	7.5	21
Meb. 804 x Meb. 140	+1	29	7.0	8.0	.72	5.3	8.1	31
Deltapine 44-51	−2	32	8.0	9.0	.86	4.7	7.8	35
Arkansas B 5	−2	26	6.0	7.4	.56	4.6	7.3	38
Holtz	−2	28	5.5	6.8	.61	5.0	7.7	29
St. x H. & H. x St. 1/28	−2	28	5.5	3.4	.69	5.4	7.4	18
Ducona x Lone Star	−2	30	7.0	6.6	.78	5.2	7.5	37
H. & H. x Acala	−2	30	7.0	5.9	.72	5.4	7.6	30
H. & H. x Acala	−2	28	5.0	6.9	.72	5.5	6.7	34
Deltapine	−2	31	6.0	5.2	.82	4.5	6.8	34
Macha x Acala 4/7	−2	28	5.0	3.9	.65	4.4	7.6	29
Macha x Acala 6/68-98	−2	28	4.0	4.8	.73	4.9	7.5	21
Western Early 4/60	−2	28	5.0	6.6	.69	5.2	6.8	22
Duc x Cl x Duc x Duc 5/63	−2	26	5.0	2.2	.70	5.2	6.9	21
Okla. Tri. x Cl. x Cl. 3/67	+2	28	4.5	6.5	.62	5.4	7.1	19
Roldo Rowden	−3	29	6.0	5.2	.65	5.4	7.5	29
Rogers Acala	−3	33	5.0	4.4	.76	4.4	8.4	24
Western Early	−4	30	8.0	8.7	.76	4.4	7.3	39
Oklahoma Triumph	−4	30	6.0	5.8	.63	4.1	7.6	42
Western Meb. 140	−4	28	6.0	4.9	.59	4.9	7.3	32
H. & H. x Acala 1/7	−4	32	5.0	4.0	.72	4.7	7.8	30
Western Early 4/63	−4	30	4.0	4.4	.68	5.0	7.2	28
Coker's Wilds 15	−5	35	7.5	15.5	.83	2.9	8.3	50
Average	−1.17	28.9	5.78	6.17	.708	4.75	7.32	31.5

The correlation coefficient between waste and change in staple of the 47 cottons is 0.40, which is highly significant. In general, it appears that the greater the percentage of waste the greater is the change in staple when the waste is removed. Two of the 5 cottons which lost 4/32 inch in staple when cleaned, had 8.7 and 4 percent waste — wastes no greater than for a number of cottons which were classed either as having no change in staple, or as being longer after cleaning.

Correlation between Waste, Grade and Fiber Properties

The relationships among grade, waste and fiber properties as measured by correlation analysis are given in Table 8.

Table 8. Correlations between waste, grade and physical properties of cotton fibers

	Waste	Immaturity	Fineness	Mean length	Classer's length	Strength
Immaturity	.541**					
Fineness	.302**	.516**				
Mean length	.222*	.323**	.527**			
Classer's length	.098	.257*	.391**	.664**		
Strength	.027	.065	.237*	.375**	.304**	
Grade	.582**	.367**	.016	.215*	.162	.120

Waste with immaturity	.541**
Independent of fineness	.472**
Independent of mean length	.509**
Independent of fineness and length	.469**
Waste with fineness	.302**
Independent of immaturity	.031
Independent of length	.224*
Independent of length and immaturity	.006
Waste with mean length	.222*
Independent of fineness	.077
Independent of immaturity	.058
Independent of fineness and immaturity	.050
Grade with waste	.582**
Independent of immaturity	.490**
Independent of fineness	.616**
Independent of length	.561**
Independent of immaturity and fineness	.516**
Independent of fineness and length	.487**
Independent of immaturity and length	.619**
Independent of fineness, immaturity and length	.521**
Length with immaturity	.323**
Independent of fineness	.070
Length with fineness	.527**
Independent of immaturity	.444**

*Significant at 5% level
**Significant at 1% level

Among the 5 fiber properties, 3 were found to be closely related to waste. These are in order — immaturity, fineness and mean length. Neither the classer's estimate of length, nor strength show a significant relationship to waste. The correlation coefficient between grade and waste is 0.582.

The correlation coefficient of 0.541 between waste and immaturity is not significantly changed when made independent of either fineness or length, or of both fineness and length. However, fineness was found to be closely associated with waste, but when independent of immaturity, the coefficient becomes 0.031, indicating that the relationship between waste and fineness was due to the relationship of fineness to immaturity. Fineness, as given in this report, is based upon weight of the fiber; therefore, it is possible to class as equally fine thin-walled coarse fibers and thick-walled fine fibers. Such a possibility emphasizes the importance of including maturity when determining other fiber properties, particularly fineness.

Although the correlation coefficient between waste and length is statistically significant, removing the effect of fineness, of immaturity, and of both fineness and immaturity, reduces it to 0.077, 0.058 and 0.050, respectively. Thus, it appears that any effect of length on waste is due to the relationship of length to immaturity and fineness. Length and immaturity have a coefficient of 0.323, which independent of fineness becomes 0.070, indicating that their relationship is due to their common relationship with fineness. There is close relationship between length and fineness, a coefficient of 0.527, which, independent of immaturity, becomes 0.444. This shows that irrespective of immaturity, length and fineness are closely related. However, length as such had no effect upon the waste.

It appears then, based on these 84 cottons, that a high amount of trash retained by long, fine cottons is not due to the length and fineness of the fibers but to the relatively high percentage of fibers with thin walls (immature fibers) which occur in long, fine cottons.

Fiber Drag and Waste

Varieties of cotton differ greatly in their resistance to separation of seeds. This resistance is called fiber drag or inter-seed fiber drag (8). It has been suggested that there might be a relationship between the fiber drag and the amount of waste in cotton and between the drag and certain of the fiber properties. The fiber drag for 43 of these cottons is given in Tables 1 and 2.

The drag ranges from 60 to 253 grams with an average of 157 grams. Twenty-two of the cottons fall below and 21 above this average. Inspection of the data in the tables suggests that there may be a relationship between drag and fineness, but correlation coefficients show that drag is not related to any of the fiber properties nor to the waste in the cotton. The partial coefficients range downward from -0.23 between drag and fineness to 0.02 for waste, which are not significant.

Apparently, resistance which fibers offer to seed separation has no effect upon the amount of trash found in the cotton.

Plant Height and Waste

It is commonly thought that those plants which are tall and have many branches result in a seedcotton which contains more leaf, stem and other plant trash than result from shorter, less branching plants. The plant height for 39 of the College Station and 28 of the Lubbock cottons with corresponding waste are given in Tables 9 and 10.

College Station

The average plant heights and wastes for the 39 College Station cottons for each of the 3 seasons are respectively 27.2 inches and 14.7 percent for 1941, 26.7 inches and 11.9 percent for 1942, and 26.1 inches and 14.6 percent for 1943. For the 3 seasons, the averages are 26.7 inches and 13.6 percent. There is little difference between the averages of plant heights for the 3 seasons. The 1941

Table 9. Plant height and waste of varieties of cotton grown at College Station during 3 seasons

Variety	Plant height inches	Total waste in 100 gms. seedcotton grams	Waste removed from seedcotton %	Waste removed from lint %	Waste in 100 gms. (as classed) grams
1941					
Gorhams Lone Star	21.2	19.3	42.0	58.0	11.2
Western Early	25.2	14.7	40.8	59.2	8.7
Macha	25.2	17.6	37.5	62.5	11.0
H. & H. x Acala	25.5	11.2	47.3	52.7	5.9
Deltapine 44-51	25.5	14.3	37.1	62.9	9.0
Ducona x Lone Star	27.0	11.4	42.1	57.9	6.6
Meb. 804 x Meb. 140	28.9	13.4	40.3	59.7	8.0
Mebane 804-50	28.9	13.9	44.6	55.4	7.7
Rogers Texacala	29.2	12.4	36.3	63.7	7.9
Oklahoma Triumph	29.2	14.5	43.4	56.6	8.2
Hi-Bred	29.2	18.5	54.6	45.4	8.4
Regular Ducona	31.1	15.1	37.7	62.3	9.4
Average	27.18	14.69	41.98	58.02	8.50
1942					
Oklahoma Triumph	24.0	12.5	39.2	60.8	7.6
Macha	24.3	16.3	23.3	76.7	12.5
Deltapine 14	24.5	12.5	44.0	56.0	7.0
Greer 5-3	24.9	8.4	16.7	83.3	7.0
Western Early	26.1	16.2	57.4	42.6	6.9
Roldo Rowden	26.1	10.0	31.0	69.0	6.9
Western Meb. 140	26.1	14.3	25.9	74.1	10.6
Gorhams Lone Star	26.3	8.4	28.6	71.4	6.0
Holtz	26.3	8.8	28.4	71.6	6.3
Stoneville 2 B	27.0	15.0	54.0	46.0	6.9
Hi-Bred	27.4	14.3	67.1	32.9	4.7
Rogers Texacala	28.0	10.6	29.2	70 8	7.5
Suntex	29.0	9.9	22.2	77.8	7.7
Mebane 804-50	30.1	10.5	42.9	57.1	6.0
Regular Ducona	30.9	11.3	27.4	72.6	8.2
Average	26.73	11.93	35.82	64.18	7.45
1943					
Gorhams Lone Star	19.8	15.0	50.0	50.0	7.5
Holtz	25.4	13.3	48.9	51.1	6.8
Arkansas B 5	25.8	13.8	46.4	53.6	7.4
Suntex	26.1	11.2	65.2	34.8	3.9
Deltapine 14	26.1	17.5	32.6	67.4	11.8
Rogers Texacala	26.3	9.9	48.5	51.5	5.1
Roldo Rowden	26.3	10.9	52.3	47.7	5.2
Western Early	26.3	16.3	36.2	63.8	10.4
Regular Ducona	26.5	12.5	40.0	60.0	7.5
Oklahoma Triumph	28.0	11.8	50.8	49.2	5.8
Western Meb. 140	28.1	11.6	57.8	42.2	4.9
Coker's Wilds 15	28.4	29.7	47.8	52.2	15.5
Average	26.09	14.56	48.04	51.96	7.65
Average for 39 cottons	26.67	13.56	41.47	58.53	7.84

and 1943 cottons contain approximately the same percentage waste, 14.7 from the tallest plants (27.2 inches) and 14.6 from the shortest plants (26.1 inches). Although the 1942 plants were slightly taller than the 1943 plants, the cotton contains much less waste.

For the 39 College Station cottons the correlation coefficient between plant height and waste in the seedcotton is 0.074, and between height of plant and percentage waste removed from the seedcotton the coefficient is -0.013, neither of which is significant. There apparently was little relationship between the height of the plants and the waste from the College Station cottons.

Lubbock

For the Lubbock cottons the averages of the height and waste for 11 cottons in 1941 are 23.9 inches and 9.7 percent; for 14 cottons

Table 10. Plant height and waste of varieties of cotton grown at Lubbock during 3 seasons

Variety	Plant height inches	Total waste in 100 gms. seedcotton grams	Waste removed from seedcotton %	Waste removed from lint %	Waste in 100 gms. (as classed) grams
1941					
Ducona x Lone Star	20.0	9.9	42.4	57.6	5.7
Hi-Bred	20.8	9.5	37.9	62.1	5.9
Clark x Meb. 140	21.4	8.9	44.9	55.1	4.9
Meb. 804 x Meb. 140	23.5	10.1	46.5	53.5	5.4
Macha	23.5	12.4	50.8	49.2	6.1
Lock. Mebane 140	24.0	7.4	50.0	50.0	3.7
H. & H. x Acala	24.1	7.4	6.8	93.2	6.9
Ferguson 406	25.0	9.0	46.7	53.3	4.8
Western Early	25.5	11.4	50.0	50.0	5.7
Deltapine	26.7	9.6	45.8	54.2	5.2
Rogers Acala	28.6	11.6	39.7	60.3	7.0
Average	23.92	9.74	41.95	58.05	5.57
1942					
Okla. Tri. x Cl. x Cl	23.8	13.2	47.0	53.0	7.0
Macha (Jones)	33.3	11.7	39.3	60.7	7.1
H. & H. x Acala	33.6	16.1	38.5	61.5	9.9
Duc. x Cl. x Duc	34.4	10.4	44.2	55.8	5.8
Hi-Bred	34.7	10.8	30.6	69.4	7.5
St. x H. & H. x St. 117	36.9	15.9	40.3	59.7	9.5
Western Early	37.1	16.2	42.0	58.0	9.4
Macha (Macha)	37.4	16.7	38.3	61.7	10.3
Deltapine	37.6	14.0	47.1	52.9	7.4
Lock. Mebane 140	37.9	8.9	34.8	65.2	5.8
St. x H. & H. x St. 111	38.1	14.3	43.4	56.6	8.1
Ferguson 406	38.9	10.2	41.2	58.8	6.0
Macha x Acala	44.5	20.6	32.0	68.0	14.0
Sh. x H. & H. x Shafter	46.3	11.8	35.6	64.4	7.6
Average	36.75	13.63	39.59	60.41	8.24
1943					
Hi-Bred	17.2	6.2	58.1	41.9	2.6
Deltapine 14	20.3	10.7	65.4	34.6	3.7
Coker's Wilds 15	21.2	11.3	53.1	46.9	5.3
Average	19.57	9.40	58.87	41.13	3.86
Average for 28 cottons	29.87	11.65	42.58	57.41	6.72

in 1942, 36.8 inches and 13.6 percent; and for 3 varieties in 1943 were 19.6 inches and 9.4 percent. For the 28 Lubbock cottons the averages of height and waste are 29.9 inches and 11.65 percent. The greatest waste occurs in 1942 when the plants were the highest as a result of heavy applications of fertilizer and water. Harvesting in 1942 was done after frost when the branches and leaves were dry and brittle. There were approximately equal wastes for 1941 and 1943 when the plant heights differ more than 4 inches.

In contrast with the 39 College Station cottons, the correlation coefficient between the height and the waste in the seedcotton for the 28 Lubbock cottons is 0.629, which is highly significant (at the 1 percent level); and the coefficient between plant height and the percentage of waste removed from the seedcotton is -0.404, which is significant (at the 5 percent level).

These results indicate that more data are needed before it can be definitely stated that there is a close relationship between the height of the plant and the amount of trash harvested. It is possible that the number and length of the branches and the brittleness of the stems and leaves may have a greater effect on the amount of trash harvested and the percentage removed than does the height of the plant.

Rainfall and Waste

The rainfall for each of the 3 seasons at each of the 2 stations is given in Table 11.

Table 11. Rainfall at College Station and Lubbock, 1941-43

	College Station			Lubbock		
	1941	1942	1943	1941	1942	1943
	Inches	Inches	Inches	Inches	Inches	Inches
January	1.55	.56	2.98	.55	.04	.04
February	3.64	1.15	.18	.61	.18	.02
March	6.63	1.27	2.17	3.56	.51	.25
April	7.91	7.79	.67	2.23	3.25	.53
May	3.06	3.91	7.04	12.69	.35	2.71
June	6.39	5.36	1.76	4.13	1.74	2.37
July	5.49	2.58	5.66	3.68	2.58	3.17
August	2.76	3.05	.50	1.85	4.97	0
September	2.67	6.17	3.14	4.47	7.61	1.16
October	6.75	2.05	.77	5.89	3.39	.10
November	1.61	5.18	2.44	.17	.01	.62
December	2.12	2.32	3.19	.72	2.70	1.87
Total	44.58	41.39	30.50	40.55	27.33	12.84
	Average for 57 years 38.82 inches			Average for 35 years 19.21 inches		
June, July and August	14.64	10.99	7.92			
July, August and September				10.00	15.16	4.33

College Station

Both the annual rainfall and that during the growing season at College Station were much greater in 1941 than in 1942 or 1943 and greater in 1942 than in 1943. In 5 of the 6 varieties grown 3 seasons, the greatest waste was found in 1941 when the rainfall was heaviest. The waste was also greater in 1941 than in 1942 for the 3 varieties grown both in 1941 and 1942. However, in 4 of the 6 varieties grown 3 seasons the waste was greater for 1943 than for 1942, although the rainfall was greater in 1942. There does not appear to be a close relationship between total rainfall and the amount of waste in the College Station cotton.

Lubbock

There were wide differences among the 3 seasons in the annual rainfall at Lubbock, 2 of which were considerably above and 1 below the 35-year average.

The average total waste and the total rainfall for each season are as follows: 9.7 grams and 40.6 inches for 1941, 13.6 grams and 27.3 inches for 1942, and 8.9 grams and 12.8 inches for 1943. The greatest waste occurred in 1942 when the annual rainfall was less than in 1941, but more than in 1943. However, the rainfall during the growing season was higher in 1942 than in either 1941 or 1943 and, in addition, there were heavy applications of fertilizer and irrigation water. The plants were unusually rank and brittle, which probably accounts in part for the greater total waste in the cotton for the 1942 season.

In 1942, the cottons had a higher percentage immaturity than in either of the other seasons, which probably accounts for the greater waste. When rainfall or irrigation is heavy, immaturity is greater; therefore, waste is greater.

Effect of Method of Harvesting on Fiber Properties

The question is frequently asked if there are any differences between the properties of the fibers of cotton harvested by different methods. It has always been assumed that there were none (9). To determine if the assumption is valid, 3 of the varieties, which were harvested by picking, snapping, and stripping, were analyzed as to fiber properties for each of the 3 methods of harvesting. The results are given in Table 12.

As expected, there are differences in grade. In each variety the grade is higher for the picked than for the stripped, and the picked higher than for the snapped in every case but one, where the

Table 12. Physical properties of fibers of 3 varieties of cotton harvested by 3 methods at College Station in 1942

Variety	Method of harvesting	Numerical grade	Staple 32nd inch	Mean length		Length at 25% point inch	Fineness micrograms per inch	Strength index	Immaturity %	Waste removed from 100 grams				
				Inches	Coef. of variability %					From seed-cotton grams	From lint grams	Total grams	From seed-cotton %	From lint %
Hi-Bred	Picked	5.0	24	.57	33	.75	5.6	9.1	36	.....	5.3	.....	.....	.....
	Snapped	6.0	26	.52	36	.71	6.0	8.9	40	.....	11.1	.....	.....	.....
	Stripped	5.5	26	.54	34	.72	6.3	8.9	40	9.6	4.7	14.3	67	33
DLP 14	Picked	5.5	30	.76	34	1.03	4.2	9.7	36	.....	5.3	.....	.....	.....
	Snapped	7.0	30	.76	33	1.02	4.5	9.4	37	.....	8.0	.....	.....	.....
	Stripped	6.0	30	.76	34	.99	4.4	9.5	36	5.5	7.0	12.5	44	56
Western Early.....	Picked	6.0	30	.77	34	1.00	4.4	9.1	38	.....	4.6	.....	.....	.....
	Snapped	6.0	29	.69	35	.92	4.4	9.3	41	.....	7.0	.....	.....	.....
	Stripped	7.0	30	.73	32	.94	4.4	9.6	36	9.3	6.9	16.2	57	43

snapped and picked are the same grade. There are no significant differences in the fiber properties. It is concluded, therefore, that any selection of cotton due to the method of harvesting does not materially affect the fiber properties.

Summary and Conclusions

The relationship between the properties of the cotton fiber and the cleaning quality of cotton has been studied in 84 cottons, which were grown during 3 seasons in 2 regions of Texas.

In general, for the 3 seasons the cottons grown at College Station were lower in grade, of approximately equal length, slightly coarser, stronger, more immature, and contained more trash than the cottons grown at Lubbock the same seasons.

There were wide differences in fiber properties of the cottons grown at each station, which are attributed to season and to variety. Although there is no apparent close relationship between the amount of rainfall and fiber properties, rainfall plus heavy irrigation and fertilizer at Lubbock in 1942 resulted in a larger plant, more trash and more immature fibers. It has been observed that seasons of heavy rainfall produce a higher percentage of immature fibers.

Of the fiber properties studied, only 3 — immaturity, length, and fineness — appear to be closely associated with the cleaning quality of the cotton. The longer, the finer, and the less mature a cotton the greater is the amount of trash retained by the fibers. However, statistical analyses show that the effects of length and fineness are due to their close relationship with immaturity. Of the 3 properties, only immaturity, as such, affects the waste. It appears that the difficulty of removing trash from long, fine cottons is not due to the length and fineness of the fibers but to the relatively high percentage of thin-walled or immature fibers which occur in long, fine cottons. Those varietal and seasonal factors which produce long, fine fibers may also produce immature fibers which retain waste. Heavy rainfall, heavy applications of fertilizer and irrigation probably acted in 2 ways in increasing the waste: first, the plants became rank with a relatively large number of leaves and branches and a large amount of trash was harvested; second, there was a higher percentage of immature fibers due to the large amount of water. When there is heavy rainfall or irrigation during the time of the formation of the secondary layers of the fibers, relatively large numbers are observed to be thin-walled or immature. Thus, there were more immature fibers, more trash was harvested, and more trash was retained by the immature fibers than in seasons of less rainfall.

This study raises the question whether there are factors which have greater influence than fiber properties on the cleaning quality of cotton. It seems quite probable that the nature of the trash may have greater influence on the quantity clinging to the fiber after cleaning than do the properties of the fiber. The shape, size, number and thickness of leaves, the pubescence of leaves and stems, number and size of branches, nature of bracts and burs, and other physical properties of the plant may have greater effect on the extent to which trash and fibers adhere than do the length, fineness, strength or other properties of the fiber. This possibility should be investigated.

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